

Areas of Particular PM USA R&D In-House Expertise

The PM USA R&D staff includes personnel with training and/or experience in most areas of science and technology. The listing below indicates the areas of particular expertise which are pertinent to the current Programs.

Alkaloid Chemistry	Chemistry of nicotine and related compounds.
Carbohydrate Chemistry	Chemistry of cellulose, starch and sugars.
Cigarette Design	Specification of cigarette parameters to produce desired smoking characteristics.
Combustion/Pyrolysis Mechanisms	Physical mechanisms & chemical pathways which control thermal decomposition.
Computer Simulation	Use of computers to replicate and predict the behavior of physical systems.
Consumer Testing & Product Evaluation	Test design and analysis to determine consumer attitudes and product preferences.
Electron Microscopy	Research applications of transmission and scanning electron microscopes and associated instrumentation.
Expansion Science & Technology	Hydrate formation, blowing processes, thermal hardening as they relate to tobacco expansion.
Expert Systems	Design of computer systems to make or guide decisions or control processes.
Filtration Processes	Physical and chemical processes to remove vapor and/or particulate components from air or smoke.
Flavor Chemistry & Formulation	Preparation of natural or synthetic compounds to produce desired subjective responses.
Image Processing	Acquisition and manipulation of digital image data for measurement, recognition or inspection.

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Instrumental Chemical Analysis	Design and use of instruments for determining the nature and concentration of chemical species.
Microwave Theory & Technologies	Use of microwaves for basic studies of materials, or operations such as moisture measurement or drying.
Neural Computing	Use of connected networks of simple computing elements for recognizing input information or determining relationships between sets of information.
Nuclear Counting	Measurement of extremely low levels of radioactivity. Use of radiochemical detectors.
Optical & Laser Technologies	Theoretical and experimental optics. Laser applications.
Organic Synthesis	Production of organic molecules from precursor compounds or elements.
Paper Making & Development	Paper design, fillers, surface treatments, manufacturing.
Perforation Technologies	High speed laser and electric spark perforation of paper.
Separation Technologies	Supercritical fluid, membrane and fixed bed separations.
Sheet-Making Processes	Cast & reconstituted tobacco sheet.
Statistical Process Control	Applications of statistical analysis to process control and problem diagnosis.
Theoretical Chemistry	Mechanisms controlling chemical structure and reactions.
Thermal Physics	Mechanisms of heat storage and transfer.

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1990
PM USA R&D Collaborative Research Programs

Program Description	Location	Budgeted Amount (\$000)	
		1989	1990
Heat Sources/Combustion Modeling/ Sigma	NY Polytechnic	907.0	579.0
Project Delta/Sigma	Stone Products	100.0	40.0
Project Beta	Pinnacle Research	200.0	100.0
Project Beta	Motorola	0.0	1,145.0
Project Beta	Coors	0.0	145.0
Gustatory and Olfactory Research/ Flavor Development	Monell	30.0	0.0
Localization of Nicotine in Tobacco/ART	Cambridge Univ.	55.1	8.8
Use of MS/MS/Analytical Support	Univ. of Nebraska/ Univ. of Pittsburgh	3.0	0.0
Study of CO Sensors/ETS	VCU	13.2	13.3
Nornicotine Determinations/TSNA	Cumberland Consulting Chemists, Inc.	8.9	0.0
Preparation of Nicotine Antibody/ART	Litron Laboratories	19.9	8.3
Two Dimensional Gel Electrophoresis/ TSNA	PDI	20.0	12.5
cDNA Expression Library/TSNA	Various	5.0	7.0

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1990
PM USA R&D Collaborative Research Programs
 (Continued)

Program Description	Location	Budgeted Amount (\$000)	
		1989	1990
Protein Sequencing/TSNA	Various	4.5	6.0
Pesticide Work	Tobacco Pesticide Group	4.0	0.0
Neutron Radiography	University of Va.	142.0	150.0
Sol-Gel Research/Paper Tech.	NY Polytechnic	135.0	135.0
Low Level Counting	Battelle NW	20.0	15.0
Inorganic Binders/Paper Tech.		0.0	36.1
Lumen Loading/Paper Tech.	Univ. of Washington	18.0	0.0
Sol-Gel Analysis/Paper Tech.	VPI	38.2	90.0
Paper Technology	Univ. of Maine	60.0	60.0
Menthol Release	Callery Chem/Lee Labs	77.0	40.0
Custom Synthesis	VCU/Aldrich/Lee Labs	0.0	183.5
Cluster Formation (Aerosols)	Colorado State	109.5	92.9
Oxidation Catalysts/Selective Filtration	Seton Hall Univ.	0.0	76.1
Project Sigma	Procedyne	229.0	0.0

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1990
PM USA R&D Collaborative Research Programs
(Continued)

Program Description	Location	Budgeted Amount (\$000)	
		1989	1990
Optical Processing	Carnegie-Mellon	54.4	40.1
Dynamic Nuclear Polarization/Analytical Support	Colorado State	31.7	0.0
Simulation of Liquids & Aerosols/ART	VPI	38.7	43.3
Single Particle Aerosol Chemistry	Univ. of Washington	0.0	35.0
Thermodynamic Properties of Supercritical Fluids	Georgia Tech.	12.0	12.5
Supercritical Extraction	Supercritical Proc. Inc.	153.4	16.0
Project ART Water Column	University of Texas	27.5	27.5
Combustion Research/Beta	MIT	25.0	0.0
Project Sigma/Beta	Laser and Mechanical Systems	5.0	90.0
Aerosol Research	VCU	0.0	14.7
Optical Processing	Unicorn Systems	1.2	0.0
Project Sigma Development	Stackpole Company	395.0	230.0
Project Beta Development	Stackpole Company	0.0	193.4

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1990
PM USA R&D Collaborative Research Programs
(Continued)

Program Description	Location	Budgeted Amount (\$000)	
		1989	1990
Project Pact		0.0	108.1
Corrosion Research/ART	Dupont Safety Mgmt.	269.2	137.5
ART Pilot Plant Design		9.6	11.0
Aquarium Disposal Studies/ART		0.0	82.9
Carbon for Plug-Space-Plug-Filter	Stackpole Company	55.0	0.0
R&D Computer Operations	Index Group	44.0	0.0
Engineering Services	Nolen, Friska, Brooks	20.0	18.9
Emergency Response Team	FDM Safety Services	22.0	21.0
Contract Programming	Computer Horizons	42.0	0.0
Contract Programming	McKinney & Assoc.	13.0	0.0
Contract Programming	Fortex	15.0	0.0
Contract Programming	Various	18.0	7.8
Total		3,451.0	4,033.2

Collaborative Research Programs are budgeted in the following accounts:
Professional Services, Consultant Services or Purchased Services.

RESEARCH PROGRAMS
1989-1990
Cosmic/Sensory Research

	<u>1989</u>	<u>1990</u>
<u>Professional Services</u>		
Dr. Mangan	\$180.0	\$118.5
Dr. Eysenck	175.0	78.6
Dr. Harley	32.0	33.1
Dr. Ashby/Dr. Nosofsky	<u>0.0</u>	<u>72.4</u>
Total	\$387.0	\$302.6

Consulting

Dr. Eysenck	\$ 3.3	\$ 3.4
Dr. Haier	1.9	2.0
Dr. Harley	2.9	3.0
Dr. Mangan	3.8	4.0
Dr. Warburton	3.8	4.0
Dr. Frijters	3.3	3.4
Dr. Falmagne	1.9	2.0
Dr. Nosofsky	1.9	2.0
Dr. Ashby	1.9	2.0
Dr. Mullen	<u>5.3</u>	<u>5.5</u>
Total	\$30.0	\$31.3

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**PM USA R&D
1989-1990 Consulting Relationships**

Program Description	Consultant	Budgeted Amount (\$000)	
		1989	1990
ANSI	R. Dawson	\$ 4.0	\$ 4.2
Regulatory Agencies	J. Stoffberg	4.8	0.0
Chemistry and Biochemistry	A. Wolf	12.0	12.5
Analytical Chemistry	F. Hawkridge	2.5	2.0
Localization of Nicotine	P. Echlin	9.2	6.8
Spectroscopy/IR Methods Development	R. Jacobsen	0.0	5.3
Elemental Analysis	T. Rains	1.5	0.0
Wet Chemistry	Cumberland Consultants	0.0	4.7
Sequencing/Protein Isolation Separation Techniques		6.5	7.4
Analysis Development	Dr. Berntson	1.5	2.0
Electrophysiology	Dr. G. Kobal	2.2	0.0
Waveform Analysis		0.0	1.5
Cigarette Paper Properties	Dr. Mattina	24.0	6.5
Organic Chemistry		0.0	6.5
Pyrolysis of Cellulose and Paper and Aerosol Formation	Dr. Chum	0.0	4.0

PM USA R&D
1989-1990 Consulting Relationships
(Continued)

Program Description	Consultant	Budgeted Amount (\$000)	
		1989	1990
Nicotine Removal and Destruction	Dr. Fair	\$ 0.0	\$ 4.0
Surface Chemistry	Dr. Somorjai	0.0	4.0
Inorganic Chemistry	Dr. Schleich	0.0	7.0
Supercritical Adsorber Columns	F. Seibert	0.0	4.2
Chemistry	D. Sawyer	8.0	0.0
Optical Components	A. Vanderlugt	7.0	7.3
Optical Processing	D. Casasent	4.0	0.0
Processing System	Dr. Fazzina	0.0	12.5
Alternate Adsorber	F. Seibert	4.0	0.0
Hydrate Technology	Dr. Sloan	0.0	2.0
Separator Design	Dr. Zenz	0.0	11.0
Structure Set		0.0	4.0
Process Modeling		0.0	8.0
Corrosion Research		3.0	0.0
Continuous Process	M. W. Kellogg	0.0	25.0
Extrusion Sigma/Beta	APV Baker	0.0	6.6

PM USA R&D
1989-1990 Consulting Relationships
(Continued)

Program Description	Consultant	Budgeted Amount (\$000)	
		1989	1990
Supercritical Fluids	University of Texas	\$ 0.0	\$ 15.1
Binder Mechanisms	Dr. Ruben	6.3	0.0
Process Engineering	Notre Dame	<u>0.0</u>	<u>11.0</u>
Total		\$100.5	\$185.1

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VISITING SCIENTISTS

1990

<u>Scientist</u>	<u>Program</u>	<u>Amount</u>
Dr. Wegscheider	Optimization in Analytical Chemistry, Chemometrics, Information Theory Related to Analytical Data	\$ 20,000
Dr. Phillips	High Speed Calculation of Complex Physics and Engineering Systems	60,000
Dr. Pat Bower	Molecular Biologist (Miller Brewing)	22,055
TOTAL		\$102,055

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Science and Technology Areas Currently Under Development at PM USA R&D

Molecular Biology	Modification of plant systems to eliminate the production of selected compounds (e.g., Nicotine).
Artificial Intelligence Systems	Expert system based computer models. Current work includes cigarette design systems.
Catalysts for CO oxidation.	Work with Seton Hall University to develop low temperature catalysts for CO oxidation.
Chemical energy sources.	Research at R&D and with N.Y. Polytechnic University to identify new heat sources for the Sigma Program.
Ceramic Technologies	Applications of sol-gels as cigarette paper fillers. Ceramic heater materials for the Beta Program.
Computer Simulations	Collaboration with Virginia Polytechnic Institute and State University to provide new insights into aerosol formation and the role of hydrates in tobacco expansion. Heat and mass transfer modeling for the Sigma Program. Flow and process simulations
Computer Technologies	High speed computing and machine communication. High performance workstations. Electronic information systems. Optical fiber networks.
Consumer Behavior Prediction	Psychophysical models of subjective response. Theories of market dynamics. Consumer testing methods.
Electrochemical Energy Sources	High energy/power density sources for the Beta Program.
Encapsulation	Release systems for menthol and/or flavors.
Fluid Jets	Accurate, high speed application of flavors or adhesives.
Monoclonal Antibodies	Rapid analysis for chemical and biochemical agents.

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Natural Binders	Improved binder systems for tobacco or sheet materials.
Neural Computing	Neural network applications to complex mapping situations. (e.g. consumer preference from demographics)
Neutron Radiography	Thermal neutron imaging of cigarettes & smoke for product and/or combustion studies.
Nuclear Magnetic Resonance	High resolution tomographic imaging. Multiple pulse analysis techniques.
Optical Inspection	High speed imaging and analysis for real time product inspection. Work with Carnegie Mellon University on measurement of size, texture, connectedness, and color of disordered structures. Methods of foreign matter identification.
Paper	Development, using facilities at the University of Maine and Western Michigan University, of new paper and paper additive processes for the Paper Program.
Remote Sensing	Non-contact sensing of process and/or tobacco streams.
Separation Technologies	Supercritical fluid, membrane, fixed and fluidized bed separations of nicotine and/or minor alkaloids.
Supersonic Molecular Jets	Fundamental studies with Colorado State University of aerosol formation mechanisms and growth and chemistry of small organic clusters.
Tobacco Expansion.	R&D work on expansion mechanisms and technologies for improved expansion processes.

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Technology Assessment

The objectives of the R&D Technology Assessment effort remain to (1) define technology related needs, (2) identify areas of science or technology which may satisfy those needs, (3) develop those areas for our use and (4) recommend and facilitate the implementation of the technology. In pursuing those objectives we continue to maintain current awareness of numerous science and technology areas as they develop commercially or at universities. The Technology Assessment Group currently maintains contact with fifteen university departments, in addition to the contacts maintained by the R&D professional staff.

Activity continues in the three previously defined strategic technology areas:

Paper: The R&D Paper Program is making significant contributions to the basic understanding of sidestream smoke generation. During this plan period, the sol-gel work supported by this program is expected to provide new paper fillers for conventional as well as innovative smoking products.

Optical Inspection: The emphasis of the Optical Processing Program is currently on the implementation of commercially available hardware (and PM proprietary software) for on-line pack inspection as well as on-press inspection of printed materials. The recently initiated studies of optically implemented morphology operators are expected to yield technologies for inspecting tobacco filler and strip by the end of this plan period.

Artificial Intelligence: An expert system based cigarette design system has been implemented. This system is expected to contribute to R&D operations by expediting cigarette design operations and, ultimately, by reducing the number of semiworks runs. Neural computing technologies continue to develop rapidly and these have been adapted to PM uses. Recent success with the prediction of consumer response from demographic data suggests valuable applications for this technology during the next five years. The growth of artificial intelligence systems for on-line process control has been slower than anticipated. These may begin to be commercially available by the end of the plan period.

Other areas areas in which members of the R&D Technology Assessment Group are currently involved include:

Catalysts for CO oxidation: This work may produce PM proprietary catalysts for mainstream smoke or ambient air in 5 to 7 years.

Chemical energy sources: Currently in use in the Sigma Program.

Computer simulations: Completed studies have enhanced our understanding of humectant systems. Current studies of hydrate and liquid drop formation are expected to make similar basic contributions to expansion and aerosol generation technologies.i

Electrochemical energy sources: These studies will continue to identify and develop energy sources for the Beta Program.

Supersonic Molecular Jet Studies: This work continues to provide basic information about the structure and chemistry during the initial stages of aerosol formation. Work aimed at increased understanding of formation mechanisms shows increasing promise.

Tobacco Expansion: New process design based on improved understanding of hydrate formation, and of blowing and fixing mechanisms is expected to produce improved expansion processes during the next 2 to 3 years.

These and similar programs will be continued into the plan period, with increased emphasis on identifying the specific needs of the R&D Major Programs. Continuing emphasis will be placed on the *implementation* of developed technologies.

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